

A method and an apparatus for feeding image plates used for intraoral dental X-ray photography into a reading device

5 The invention relates to a method for feeding image plates used in intraoral dental X-ray photography into a reading device for the images taken on the plates to be read. The invention also relates to an apparatus for carrying out the method in question.

10 In intraoral dental X-ray photography, the image plate inserted into the patient's mouth is exposed to X-radiation in order to excite an excitable layer on the plate, such as a phosphorus layer. After the photographing step, the plate surface is read with a scanning laser beam to produce an image. After the reading step, the image information is removed from the plate by means of a clearing light to allow the plates to be reused.

15 FI layout print 90471 describes the reading and clearing of an image during a reciprocating movement generated by a pulling device, which attracts the plate magnetically. The publication states that the pulling device retracts the plate from a cassette, in which the plate has been located during the photographing step. FI layout print 92633 further describes a protective bag of plastic film permeable to X-rays, in which the image plate is located during the photographing step. After the photographing step, the plates are transferred one by one to a reading device, the transfer taking place according to the publication so that the magnet included in the pulling device attracts the end of the plate located in the bag, and after this the bag is withdrawn from around the plate.

25 US patent specification 5,635,728 discloses a solution for reading image plates in connection with dental intraoral X-ray photography, in which the plates are manually fixed one by one in vertical and horizontal rows on the outer surface of a cylindrical, rotatable cassette. The cassette is placed in a reading device, where a scanner reads the plates one horizontal row at the time while the cassette is rotating, or where plates are read one vertical row at the time by shifting the scanner vertically with the cassette immobilised during the reading of each row. This technique has the inconvenience of awkward attachment of the image plates to and detachment from the cassette after the reading, and also of requiring flexible plates. To attach and detach the plates, the cassette has to be detached from the reading apparatus, thus interrupting the reading, unless two or more alternating cassettes are

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available. In addition, to gain effective benefit by the method, all the plate sites of the cassette should be occupied. If there are unoccupied sites in the plate rows, as there will be if the number of plates to be read is smaller than the number of plate sites, part of the reading capacity will be lost due to idle running of the apparatus, entailing unnecessary costs and waste of time.

The object of the invention is to provide a solution for bringing image plates used in dental intraoral X-ray photography to the image reading step in a manner that overcomes the inconveniences described above. The invention can be applied to reading techniques, where a slide acting as a conveyor transfers image plates one by one to be read by a scanner, and it is characterised by the fact that the plates are removed from their casings used during the photographing step, that the plates are stacked into a housing which acts as an intermediate storage and is substantially protected from light, and that the plates are delivered forwards from the housing by means of a conveyor, which grips the plate in the housing to be delivered next and moves it forwards on the feed path.

It is easy to place image plates to be read in the housing, extending a pack of plates which may already be there, and it can be done freely, independently of the actual reading process. Plates can be added not only one by one but also as bundles of several plates. When the plates are in the housing, they are submitted to further handling, i.e. transferred with a conveyor e.g. within reach of a separate slide in the reading device, and subsequently automatically transferred by the slide to be read by the scanner. Hence the system does not require monitoring, and, unlike the techniques of US patent specification 5,635,728, it only handles and reads plates that have actually been brought into the apparatus, without idle running. The invention does not either necessarily require flexible plates.

It is advantageous to arrange the image plates as a pack in the housing, where an active force pulls or presses the plates towards a conveyor tangential or adjacent to the housing, the conveyor gripping the plate which is closest each time in order to move it forward on the feed path. The image plates in the housing can be pulled or pushed towards the conveyor within reach of the conveyor gripping means in several ways. One advantageous solution is to tilt the housing bottom towards the conveyor so that the plates in the pack are pulled towards the conveyor by force of gravity. Besides or instead of this, the plate pack can be pushed towards the conveyor by means of a pushing device behind the pack. The pushing device may advantageously consist e.g. of a roll rolling freely on the inclined housing bottom. Optionally, the pushing device can be connected to a power source, and then no

inclined housing bottom will be needed. One further solution, which can be used separately or as a complement to the solutions mentioned above, is to provide the image plates with a magnetic metal part which is attracted to the conveyor with the aid of a magnet.

- 5 A conveyor on which image plates are transported to the path of the reader slide is advantageously formed by a moving toothed belt conducted in the vertical direction laterally of the housing, where the teeth interval has been dimensioned so as to match the plate dimensions in the direction of movement of the belt, the belt then entraining with its teeth a plate which has penetrated between the teeth. The
10 retention of the plate on the belt during the transfer can be ensured by means of one or more magnets mounted on the side of the belt, or optionally a cover can be mounted on the side of the belt, so that the plates pass in the narrow interstice between the belt and the cover, from where they cannot drop from the belt.

- The movement of the belt or chain acting as a conveyor is preferably stepped with a
15 step length appropriately slightly longer than the image plate dimension in the direction of movement. The conveyor belt or similar will thus grip the closest plate of the plate pack in the housing and remove it from the pack before stopping at the end of the step, and the next plate in the pack is subsequently allowed to press against the conveyor. The conveyor transfers the plate in one or more steps into a
20 position where the reader slide can grip the plate and transfer it to the reading step. The slide may be adapted to make reciprocating movements so as to, after the plate has been read and perhaps subsequently cleared, return the plate onto the conveyor, the conveyor being immobilised over the entire duration of these operations. With
25 its following step, the conveyor removes the plate that has been read from the process, e.g. by simply letting it drop from the conveyor, while simultaneously bringing the following plate to the location of the reader slide.

- As mentioned above, the invention also comprises an apparatus for feeding image plates used in intraoral X-ray photography into a reading device for the reading of the images taken on the plate. The apparatus is characterised in comprising a
30 conveyor and a housing which acts as an intermediate plate storage and is substantially protected from light, and into which the plates can be stacked and from where the conveyor is adapted to grip plates with its gripping means to move them forward in sequence from the apparatus.

- The invention is described in greater detail below by means of an example and with
35 reference to the accompanying drawings, in which

figure 1 shows an apparatus of the invention for receiving image plates excited in dental X-ray photography and for transferring them within reach of a slide included in a reading device, without conveyor belts integrated in the apparatus,

5 figure 2 shows a front view of the apparatus of figure 1 and said reader slide,

figure 3 is a view corresponding to figure 2, showing the apparatus including conveyor belts, with the plate housing and the cover parts removed, and

figure 4 is a cross-section of the entire apparatus along IV-IV of figure 3.

10 The apparatus illustrated in the drawings is intended to transfer one by one digital image plates 1 excited in intraoral dental X-ray photography for the images to be read by a laser beam. An image plate 1 consists of a thin, rigid or semi-rigid plate, which is preferably mainly made of plastic and which can be equipped with a magnetic metal part in order to utilise magnetism in the shifting of the plate. The surface of the image plate 1 comprises a layer of phosphorus or phosphoric material
15 excited by X-ray photography. In the photographing step, one or more image plates are inserted into the patient's mouth in a plastic bag, which gives protection against saliva and daylight, and in which the X-radiation excites the phosphorus layer on the plate. After the photographing step, the plates 1 are removed from the protective bags and are pushed into the plate housing 2 integrated in the apparatus described.
20 After this, the handling of the plates 1 proceeds automatically so that the apparatus transfers plates one by one from the housing 2 onto the path of the reader slide 3. The slide 3 grips a plate 1 and makes a reciprocating movement, during which the plate is scanned with a laser beam in order to produce the final X-ray photograph on a film or a display terminal, and a clearing light clears the plate from image
25 information for the subsequent X-ray photographing session. The slide 3 resuming its initial position returns the image plate 1 which has been read and cleared onto the path of the apparatus, which then carries out the removal of the plate.

30 The apparatus described above, in which the image plates 1 are transferred vertically from the top to the bottom, comprises a frame 4, rolls 5, 6 mounted on bearings in the frame and including axes 7, 8 at the upper and lower ends of the apparatus, endless conveyor belts 9 steered by the rolls, and an engine 10 rotating the rolls 5 at the upper end of the apparatus. The conveyor belts 9 form a vertical transfer path for the image plates 1, the path being defined by the plate housing 2 mentioned above and a cover plate 11 below the housing, the cover plate being

spaced from the belts by a distance barely allowing the plates to pass between the plate 11 and the belts. Magnets 12 have been placed on the opposite side of the conveyor belts 9 in order to enhance the pressing of the image plates 1 against the belts, enabling these to grip the plate, and to ensure that the plates are retained on the belts until the slide 3 grips the plates in order to transfer them to the image reading step.

The plate housing 2, where the image plates 1 to be read can be placed in a pack as in figure 4, comprises a bottom 13 inclined towards the conveyor belts 9, a sliding door 14 on the side of the housing, and a freely rolling roll 15, which is placed behind the plate pack in the housing and which pushes the plates 1 towards the belts by force of gravity. The gripping means with which the conveyor belts 9 grip the closest plate 1 of the plate pack in the housing consist of projecting teeth 16, spaced by an interval substantially equal to the width of the rectangular plates placed transversely in the housing. Thus the plate 1 fits into the gap between the teeth of the belt 9, where, pulled by the belts, it moves downwards into a position in the lower part of the apparatus where the reader slide 3 can grip the plate.

The movement of the conveyor belts 9 generated by the engine 10 is stepped in the apparatus, the length of each step equalling a tooth interval, i.e. the distance between the teeth 16. The conveyor belts 9 are immobilised between the steps. The apparatus described here has been dimensioned so that the plate 1 moves from the housing 2 onto the path of the reader slide 3 in two steps. The belts 9 are immobilised over each period that the slide makes its reciprocating movement in order to read and clear the plate. When the slide 3 has returned the plate onto the transfer path formed by the belts 9, the belts take the following step, which brings the subsequent plate to be read to the location of the slide while letting the precedent, already read and cleared plate drop from the belts.

In the apparatus described above, the bottom 13 of the plate housing 2 is inclined, a roll 15 pressing the pack of plates has been placed in the housing, and on the side of the conveyor belts 9 opposite to the plate pack a magnet 12 has been placed, which attracts image plates 1 comprising magnetic metal parts. All of these three factors, which have been exemplified in the drawings, contribute to the pressing of the image plates 1 against the conveyor belts 9 and to the engagement of the plates between the teeth, for the plates to be moved forwards on the transfer path formed by the belts. In the practice, all of these factors are not necessarily called for at the same time, so that it may suffice to provide merely the inclined bottom 13 of the housing 2 or the pushing device 15, or even only a pushing device actuated by a

separate actuator in a housing having a horizontal bottom, and then the plates do not require any magnetic parts either. Accordingly, with the use of a magnet 12 behind the pack of plates, the pushing device may be superfluous. The second magnet 12 placed lower in the apparatus, as shown in figures 3 and 4, and the cover plate 11
5 defining the transfer path of the plates may also offer optional solutions to ensure the retention of the plates.

It is obvious to a person skilled in the art that the various embodiments of the invention may vary also in other ways without departing from the scope of the accompanying claims.